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ONTARIO

Department of Education

Proposed Course of Study

Grade XII

BIOLOGY

Issued by Authority of
The Minister of Education

PROPOSED COURSE IN BIOLOGY

GRADE XII

This outline of the proposed course in Biology for Grade XII is submitted for the consideration of teachers of Science in High and Continuation Schools and Collegiate Institutes. The course will not be introduced before September, 1940, and possibly not until 1941.

Constructive criticism and suggestions for the further improvement of the course as outlined will be welcomed, and may be forwarded to the Department of Education. Opportunity for discussion of the course may be given at the Easter sessions of the Ontario Educational Association in 1940.

Objectives

The objectives of the course may be stated as follows:

(a) To extend, in the field of Biology, the objectives of the earlier course in General Science;

(b) To emphasize the orderly system of animate nature;

(c) To develop an appreciation of the relation between the system of nature and human activities;

(d) To encourage an understanding of the application of biological principles to the conservation of natural resources.

With these objectives in view, and keeping the importance of Biology to civilization to the fore, the course lays emphasis upon the study of the organism as a "going concern", and upon the study of the interactions of organisms. Morphological and physiological studies are reduced to the minimum needed to identify the plants and animals composing the systems studied, and to understand their reactions to their surroundings. More advanced studies of morphology and physiology are reserved for Grade XIII.

The course calls for active participation on the part of the pupils. It is suggested that problems involving organized observations in the field be combined with class work. Although these activities will vary with varying localities, problems may be worked out in any area through projects adapted to that locality.

It is recognized that climatic conditions in Ontario determine to a large extent the type of biological work that may be done in any season, and the syllabus permits wide rearrangement of details. At the same time it is suggested that winter is not an entirely "dead" period out-of-doors and that the season of spring thaw affords opportunities of studying some biological problems that have important bearings on human affairs.

The time allotted to each section indicates in a general way the "depth" of treatment intended. Teachers who wish to emphasize certain elements in the syllabus with reference to local conditions may do so without destroying the broad plan. It is important, however, to bear in mind the purpose of the course—the building up of a scientific understanding of biological principles and the development of an appreciation of their importance to our civilization.

PROPOSED COURSE IN BIOLOGY—GRADE XII

Recognition of plants and animals and their habitats. (Nine periods.)

A study of as many as possible of the following:

(1) Twelve trees, twenty flowering shrubs, six ferns, and several characteristic mosses and fungi;

(2) Twenty birds, six reptiles, six amphibians, and several mammals, fish, and insects common to the locality.

The study of plants, by means of field trips, development of school gardens, and observation of collected specimens should begin early in the autumn and continue throughout the year. Each plant should be identified and its habitat noted.

Attention should be directed to species of trees common to: (a) swamps, (b) rocky country, (c) wet sand, (d) dry sand, and (e) land along water courses. Note should also be made of flowering plants common to: (a) lawns, (b) cultivated fields, (c) grasslands, (d) dry roadsides, (e) moist roadsides, (f) dry rocks, (g) woodlands, and (h) land along water courses.

The study of animals will follow lines similar to those described for plant study. Note should be made of birds common to: (a) marshlands, (b) meadows, (c) orchards, (d) evergreen bush, (e) hardwood bush, and (f) rivers and lakes. Other animal forms may be treated in similar groupings.

NOTE—The indiscriminate collection of native forms should be discouraged.

Classification of plants and animals. (Nine periods.)

The recognition of simple structural differences in groups of flowering plants, ferns, etc.

An examination of flowers of six or more plants to show diversity of structure, and to serve as a basis for the study of such relations as pollination, and for simple classification. Examples from the following families are suggested as suitable: Liliaceae, Ranunculaceae, Cruciferae, Rosaceae, Leguminosae, Aceraceae, Ericaceae, Labiatae, Compositae.

(Five periods.)

A survey of a number of mammals as a basis for the study of interrelations and for simple classification. Examples from the following families are suggested as suitable: Insectivora, Carnivora, Ungulata, Rodentia, Cheiroptera, Primates.

A survey of a number of insects as a basis for the study of interrelations and for simple classification. From three to six examples from each of the following orders of insects are suggested: Orthoptera, Diptera, Odonata, Lepidoptera,

Hemiptera, Homoptera, Hymenoptera, Coleoptera. (Life histories are not expected.)

Use of the Key: The method of using a key should be demonstrated by tracing the identification of plants already collected and known. Then practice should be given in identifying plants not known to the student. The use of keys for identifying animal types should be introduced in a similar way.

The plant and animal as an organism and an individual.

ANIMALS.

(One period.) STRUCTURE AND FUNCTIONS:

The structure of the human body as studied in Grade X should be recalled as representing that of mammals in general Recall also the organ systems and general functions.

(One period.) INTERRELATION:

Interrelations of digestion, circulation, excretion (kidneys), respiration.
Interrelations of muscles and skeleton.

(One period.) INTEGRATION:

The integrative action of the nervous system. Hormones, e.g., thyroxin, as chemical messengers, and also as controlling mechanisms.

(Two periods.) ASSOCIATION:

Recall the cells of an organism; the unicellular animal as an independent organism.

Need for co-ordination of groups of cells in the higher animals. Division of labour.

Association of multicellular animals (social insects).

Ecological community. Note animals common to a habitat, e.g., forest, field, pond, stream.

PLANTS.

(One period.) STRUCTURE AND FUNCTIONS:

Recall the structure of higher plants; the root and shoot; the tissue systems, e.g., supporting tissue; the general functions.

(One period.) INTERRELATION:

Interrelations of absorption, conduction, photosynthesis, respiration, transpiration, storage, digestion.

(One period.) DIFFERENTIATION:

Differentiation of structure during growth so as to produce a unit of co-ordinated parts.

Examination by a hand lens of cross-sections of a growing stem at various levels from the tip down, to show differentiation of tissues.

(One period.) CONTROL BY APICAL REGION:

Inhibition of branch development from axillary buds. Remove terminal bud from a growing shoot and note development of axillary branches.

(One period.) PRACTICAL APPLICATIONS:

Note effect of cutting back hedge plants, annuals, trees, etc.

Organisms in relation to their environment.

PLANTS, in relation to:

(Two periods.) LIGHT:

Production of chlorophyll;
Photosynthesis;
Lengthening of plants;
Structure of leaves—shade and sun plants;
Time of flowering (photoperiodism);
Tropism.

(Two periods.) WATER:

Uses of water to a plant;
Hydrophytes, Xerophytes, etc.;
Absorption;
Tropism.

(Two periods.) TEMPERATURE:

Effect on metabolic rate—growth depending on favourable temperature;
Effect on germination of seed, dormancy of seed;
Effect on transpiration.

(Two periods.) CHEMICAL FACTORS:

Chief nutrients, as indicated by deficiency;
Oxygen requirements of roots;
Alkali soils and acidity.

(One period.) GRAVITY:

Tropisms.

(Six periods.) BIOTIC FACTORS:

Pollination by wind and insects—adaptations for each;
Seed dispersal;
Competition—struggle for light and water;
Grazing—plants not desired by grazing animals gain ascendency (thistles, buttercups);
Insect depredations;

Fungi, parasitic and saprophytic; the role of saprophytes in producing humus, and the restoration of elements for further plant use.

ANIMALS, in relation to:

(Two periods.)

LIGHT:

Tropism—insects (larva, adult);
Habits—nocturnal; diurnal;
Pigmentation—Vitamin D;
Protective colouration—inherited;
Photoperiodism—breeding habits; migration (determined by length of day).

(One period.)

WATER:

Uses to the animal;
Gill breathing;
Swimming;
Adaptations to water habitat; amphibians; requirements of land animals.

TEMPERATURE:

Warm-blooded and cold-blooded animals;
Hibernation;
Body covering;
Migration;
Food variations with changes in temperature;
Rate of metabolism.

(One period.)

CHEMICAL FACTORS:

Foods (Grade X Course);
Oxygen requirements—aquatic animals—migration,
—cold-blooded vertebrates,
—warm-blooded vertebrates;
Other chemicals, e.g., salt.

(Four periods.)

BIOTIC FACTORS:

Struggle for food:
(a) herbivorous animals;
(b) carnivorous animals;

Means of protection of the individual:
(a) escape —hiding (passive),
flight (active);
(b) defence—passive,
active;

Race protection:
(a) number of offspring;
(b) period of gestation;
(c) care of young;
(d) period of life cycle;
(e) other devices, such as hunting packs, defensive organization, etc.

(Three periods.) FURTHER STUDY ON ADAPTATIONS (any three):

(1) Compare the bills of birds and show how these are adapted to their feeding habits.
(2) Compare the feet of birds and show how these are adapted to habit.
(3) Compare the adaptations for flight possessed by birds, bats, and the flying squirrel.
(4) Look for examples of climbing plants and note the modifications of structure for the role.
(5) Look for the adaptive features of some one plant (e.g., the dandelion) that fit it successfully to its environment.

Plant-animal communities.

(One period.) COMMUNITY TYPES:

A study of a typical aquatic community, a marsh community, and a forest community.

(Two periods.) SUCCESSION:

Bare area—land—xerarch, dry beginning;
—water—hydrarch, wet beginning;
Invasion—seed dispersal (and spore dispersal);
Ecesis—establishment and reproduction;
Aggregation—increase in numbers;
Competition—shading out;
Reaction—effect of the plant on the environment; shade, humus;
Invasion of new environment by other plants;
Stabilization—climax vegetation; forest, grassland determined by climate; secondary invasion.

(One period.) PLANT-ANIMAL COMMUNITIES:

Role of animals in relation to the plant community;
Coaction.

(Two periods.) CLIMATE:

Climate in relation to biotic associations;
The Life Zones of North America.

Balance of nature.

Recall Courses of Grades IX and X.

(Three periods.) FOOD SOURCE:

Food manufacture by plants; sources of raw materials; sunlight as the source of energy. Amounts of stuffs used and made by plants. The cycle of the elements, e.g., carbon, nitrogen, minerals.

(Two periods.) FOOD-CHAINS:

Green plants—herbivores—carnivores.
Examples to show that food-chains are the basis of natural balance.

Food-chains: List a number of food-chains such as owl—mouse—grass; wolf—deer—foliage; etc.

(Three periods.)

PYRAMID OF NUMBERS:

Recall combustion in the body; fuels and foods. Energy transformations. The surface-mass relation and its consequence that among warm-blooded animals smaller forms eat more food in proportion to their size than larger. Hence, the food-chain relations involve over a period of time, say a year, a large mass of vegetation supporting a smaller mass of herbivores, which in turn supports a smaller mass of carnivores.

Cut up a cube of potato to show increasing surface while the mass remains constant.

Pyramid of numbers: e.g., 1 owl—1000 meadow mice—11 tons grass (65 lbs. per mouse per year). Try to work out similar pyramids.

Biology and Economics.
(Eight periods.)

The necessity of adequate ground cover for the continuance of normal life.

The ways in which civilization disturbs the natural balance; the dangers of these disturbances in the reduction of animal life, e.g., insectivorous birds, or in encouraging troublesome forms, e.g., herbivorous insects and mammals that feed on crops. Methods of control; the importance of food-chain relations in these, e.g., the food of predatory birds; insect parasites; insectivorous birds.

The tendency of introduced plants and animals to increase out of balance.

Alteration of balance by controlling some link in a food-chain, e.g., killing predators.

The biological effects of water pollution; alteration of water levels; dams; etc.

The need of preserving a balance of plants, or of restoring one where it has been destroyed. Reforestation.

Note the effect of removing ground cover, e.g., forests, on:

(1) ground—erosion—loss of fertility;

(2) water, rapid run-off increasing erosion, producing floods in spring, droughts in summer.

Note the effect on plant and animal life both in water and on land.

Name six animals (mammals, birds, insects), and six plants that have invaded Canada and have increased out of balance.

Show how the balance has been upset and discuss methods of restoring it.

PROJECTS TO ACCOMPANY THE SYLLABUS

The general aim of the course is to relate the pupil to his biological environment, increase his appreciation and understanding of that environment, quicken his enjoyment of the out-of-doors—near at hand as well as further afield—and instill in him the need for conservation of all forms of plants and animals now existing in his immediate neighbourhood and in the Province at large. With this in view, it would defeat the purpose of this course to encourage the indiscriminate collection of native wild flowers by large numbers of pupils as individual projects. Rather have the pupil discover, study, and enjoy the wild forms in their natural habitat; and, for recognition and evaluation of his discoveries and studies, have him submit a report on the specific location, nature of the habitat, conditions of light and moisture supply, associated plants, accessibility to, and probable disturbance from, animal types in the locality (including man). Encouragement might be given to the photographing of discoveries, taking general views of the habitat, and close-ups of the specific forms under consideration.

In regard to field work, this may commence right in the school yard. Field work does not necessarily imply excursions to distant points, although an occasional excursion, planned for and with certain definite aims, is very desirable and definitely stimulating to the class and instructor. In urban centres the vacant lot, park, private lawn and hedge, back yard and garden may provide the "field" for a great deal of a pupil's observation. In communities of smaller population, the pupil's excursion will probably take him into more natural and untrammeled areas. However, of no less importance is the work of the urban pupil in observing the influence of a congested population on the plant and animal life within the city limits and the suburban territory.

A wide range of projects is given from which a few, suitable to the locality, may be selected. Projects may vary from year to year, and some, by their nature, may be followed through for a number of years. It is not intended that pupils be asked to make individual collections of insects, leaves, etc., but rather that they be encouraged to bring in occasionally specimens which may be used to make up permanent school collections. Time has been provided in the course for pupils to make reports on their investigations and surveys.

COLLECTION PROJECTS:

A—Plant Collections:

- Dry fruits.
- Weeds.
- Flowering plants: (a) taxonomic collection;
  (b) ecologic collection.
- Conifers (leaves, cones).
- Twigs.
- Leaf collection or leaf prints.
- Devices for seed dispersal.
- Ferns, clubmosses, horsetails.
- Mosses.
- Wood sections.
- Plant galls.

B—Animal Collections:

Insect collection, classified taxonomically.
Insect collection, classified economically.
Insect collection, classified in relation to pollination.
Insect collection, classified parasitically.
Shell collections, mollusca.
Amphibian terrarium.
Reptile terrarium.
Mammals' skins.
Mammals' skulls.

EXPERIMENTAL CONTROL PROJECTS:

Grow plants under various conditions of moisture.
Grow plants under various conditions of light.
Grow plants under various conditions of soil.
Grow plants under various conditions of temperature.
Experiments on seed germination: (a) suitable conditions;
(b) dormancy;
(c) viability.

Experiments to show the effect of chemicals on plant growth, as water cultures, soil-less gardening, growth in pure silica sand.
Experiments on transpiration.
Tropisms: (a) light;
(b) gravity;
(c) moisture;
(d) contact with solid objects.

SUCCESSION PROJECTS:

These are roughly divided into projects connected with succession in space and those connected with succession in time, but the distinction is not sharp.

A. In Space:

1. Make a sketch plan of a pond with a marshy margin, showing the zones of vegetation round it corresponding with the amount of wetness. (Similar zones may often be found in the water.)

   Marsh—note zonation:

   (1) Underwater plants—weak-rooted.
   (2) Floaters—leaves and flowers floating, rooted, relation to light, air passages.
   (3) Cat-tails and bulrushes—air chambers, waxy cuticle, light penetration to bottom, poor absorption.
   (4) Sedges—cuticle, flooding in spring.
   (5) Shrubs — advantage of perennial woody form, absorption.
   (6) Trees.

   Note nature of the soil—accumulation of humus and silt, aeration in later stages.

2. If a lake beach is available, study the gradual change in the vegetation as you recede from the water. Sometimes there are also well-marked belts of vegetation in the water. On what kinds of beach are the aquatic belts best developed?

3. If a sandy area adjacent to a woodlot is available, make a study of the changes in the plants as you go from one area to the other.

4. If a swamp is available, study the arrangement of the plants with reference to the degree of wetness.

5. In any of the foregoing projects, note, as opportunity offers, the corresponding succession of animals. In the successions associated with water, molluscs will often provide good material; and different kinds of frogs occupy different zones. Between woodland, open country and marsh, birds often show marked successions, and similarly do insects.

6. If in rocky country, study the succession of plants on exposed rocks.

7. Note the dominant birds in a woodlot and compare them with those dominant in the adjacent open country.

8. As in 7, compare the dominant birds of an alder swamp with those of the adjacent country.

9. Compare the mammals of woodlot, meadow, cedar swamp, etc.

10. Make a sketch map of a stream, or of part of one, showing rapids, shallows, deeps, stretches shaded by trees and by shrubs, and where open; show on it what aquatic plants and animals are found in each situation.

B. In Time:

1. Observe the succession of plants in a neglected pasture, and in a burnt-over area.

2. From year to year make notes on a pond that is gradually filling in naturally, noting the succession of plants as the habitat changes.

3. If a suitable stream flows into a lake, note the changes taking place in the neighbourhood of the stream's mouth.

4. Note the changes in the composition of local forests, tending towards a climax.

5. In a woodlot note what plants flower in spring; in summer; in fall.

6. In a meadow note what plants flower in spring; in summer; in fall.

7. If any raw earth has been exposed, for example the sides of a cut made when grading a road, or the sides of a fill, note what plants

appear first, and what happens later on. Are there any factors under the conditions suggested above that interfere with the free growth of plants?

8. In an ungrazed woodlot estimate the number of seedling trees, saplings and small trees of various ages, and compare the number with the number of large trees.

9. Make a comparison like that of 8 in a grazed woodlot.

REFORESTATION AND RELATED CONSERVATION PROJECTS:

(The following outline applies mainly to agricultural Ontario; it would need extensive modification to be useful in the forested areas.)

What is now agricultural Ontario was originally largely covered with forests—some 80%—and the physiographic features, including the top-soil, developed under forest conditions, with almost no loss by erosion, with high water-retention, and consequently numerous permanent streams and ponds.

The development of agriculture necessarily made very great changes in these conditions, with results that are now making themselves felt in several ways; e.g., lack of water, floods, and lack of fertility.

NOTE—Maps are very useful in economic biological studies. The most useful are the National Topographic Series, 1 inch to 1 mile, but these are only available for limited areas. The next best are the National Topographic Series, ½ inch to 1 mile, which are available for considerable areas. And there are the Standard Topographic Maps, with much less information on them, ¼ and ⅛ inch to 1 mile (approximately). In any case it is desirable to enlarge the parts of the local sheet to a scale of about 4 inches to 1 mile.

The 1 inch to 1 mile maps exaggerate water; in many cases the blue line of a stream indicates a watercourse rather than an actual stream.

Water Projects:

1. Make a survey of the country round the school to find which streams are now permanent and which temporary. At what seasons does each flow? Is the water clear or muddy? What is the difference between extreme high and low levels? Which streams flood and to what extent?

2. Which streams rise in woodlots, or have tributaries in woodlots? Similarly which arise in swamps? Is there any connection between their origins and their permanence?

3. Plot on a map all mill dams, intact or washed out; note the number of mills now adequately supplied with water, and of those lacking water.

4. Note the kinds of animals associated with permanent and temporary streams.

5. Note the kinds of fish found in permanent streams exposed along most of their course, and in those largely sheltered. What differences of average temperature do you find?

6. Plot on a map all marshes; note whether they are drying up or not. (There is a chance to study succession here.)

7. Plot on a map all ponds, marking the temporary and permanent ones; note especially any that have become temporary recently. (Again note succession.)

8. Make a survey of wells. Find which have gone dry, permanently or occasionally; which give some water, but not enough; which are adequate. Note the distance of the surface of the water from the surface of the land. Note those that have been deepened, and by how much.

9. If a convenient stream runs through a town or village, compare its condition above and below.

Soil Projects:

1. Make a Detwiler erosion apparatus.

2. Note places in streams where erosion is taking place. How much soil is being washed away per year?

3. Note any gullies that are being eroded, and at what rate.

4. Take samples of water from streams in flood and find how much solid stuff will settle out from water taken from:
   (a) streams fed mainly from exposed land;
   (b) streams fed mainly from land under crops;
   (c) streams fed mainly from land under grass;
   (d) streams fed mainly from land under trees.

5. Observe sloping ploughed fields after rain; note the influence of the direction of the furrows on runoff and on transportation of silt. Observe fields with various crops after rain and compare the amount of silt washed down.

6. Make soil sections in woodlots and in various kinds of cultivated fields; note the differences in the amount of topsoil.

Tree Projects:

1. Plot on a map all woodlots in any convenient area round the school; indicate which are grazed and which ungrazed. Estimate the total amount of each in the area. What per cent is this of the whole area? (Belgium has 18% of her whole area under trees; Germany, 27%.)

2. Observe the differences between a grazed and an ungrazed woodlot; note especially the difference in the state of the ground and of the seedling trees.

3. If possible, find woodlots that have been once grazed but are now fenced; note the gap in the size of the trees.

4. If possible, find woodlots that have been so continuously grazed that they are dying out, with grass replacing the trees.

5. Mark on a map all demonstration woodlots; try to discover the date at which each was made a demonstration woodlot. Visit several that have been demonstration lots for different lengths of time and compare them with other lots, both grazed and ungrazed, that are not demonstration lots.

6. Note on a map all plantations, keeping the map up to date; visit several of different known ages and report on the height of the trees, the amount of duff, other plants associated with the trees, animals, etc.

7. Plot on a map all areas of recent cutting of woodlots, keeping the map up to date from year to year. Note whether the cutting is complete, or whether only selected trees are taken.

8. On areas of complete cutting note what succession of vegetation appears; and the effect that this has on the animals.

9. In any year estimate whether the amount of wood cut in your area is replaced by the growth of what is left; i.e., whether the total amount of woodlot is increasing, is stationary, or is decreasing.